



# Bently Rotor Dynamics Research Corporation

*Improving the reliability and availability of rotating machinery*

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**B**ently Rotor Dynamics Research Corporation (BRDRC) is a wholly-owned subsidiary of Bently Nevada Corporation, located in Minden, Nevada. It offers specialized expertise and modern technological resources to develop practical solutions to industrial machinery behavior problems. It is comprised of a knowledgeable, field-experienced staff whose technical backgrounds cover a broad range of engineering disciplines including mechanical, electrical and computer science. With experience on many types of rotating machines, such as steam and gas turbines, motors, generators, compressors and pumps, BRDRC personnel combine field experience with laboratory simulations, analytical modelling and computations to solve machinery dynamic problems.

While BRDRC personnel take an active part in Customer Training Services and lecture at Bently Nevada Seminars, their expertise is eagerly shared with anyone wishing to learn more about rotating machinery dynamics and vibration monitoring diagnostics. Copies of published technical papers and reports are available upon request.

Through the study of fundamental and advanced dynamic rotating machinery behavior principles, BRDRC's staff provides diagnostic methodology rules for vibration monitoring, as well as guidelines for the appropriate use of diagnostic electronic instruments. The acquired experience establishes specific design recommendations for rotating machines to minimize vibration-related

malfunctions. Correctly diagnosing machinery problems has prevented numerous machine failures.

At the forefront of research studies, BRDRC has operated with two primary objectives since its formation in 1983:

1. To contribute to the field of knowledge on the dynamic behavior and performance of rotating machinery.
2. To support Bently Nevada Corporation's engineering efforts by advancing electronic instrumentation technology for measuring, monitoring and evaluating the mechanical performance of rotating machinery.

BRDRC researchers continue to perform analytical and experimental studies on rotating machinery dynamics. Their results have established mathematically-described and physically-documented basic laws regarding:

• **Dynamic effects of shaft cracks** - physical causes of shaft cracking, shaft crack prevention, and methods of early shaft crack detection through vibration monitoring.

• **Identification of modal parameters in coupled rotating systems consisting of elastic elements (e.g. shafts with solid/fluid interaction)** - use of synchronous and nonsynchronous perturbation techniques for machine-simulating experimental models and actual machines. Research in this area resulted in the identification of a new, more adequate, model of fluid-induced rotor instabilities, successfully replacing

the "standard" linear fluid dynamic model that has been used for seals and lightly-loaded bearings during the last fifty years.

• **Misalignment effects, detection and prevention** - mathematical models showing substantial effects of rotor misalignment on rotor stress patterns and practical correction using optical and laser equipment.

• **Fluid-induced instabilities of rotors in fluid-lubricated bearings and/or seals, blade tip clearances of fluid-handling machines** - instability threshold prediction, fluid whirl/whip self-excited vibration occurrences as two varieties of the same phenomenon, amplitude and phase evaluation of these vibrations, modes of coupled instabilities, instability source location identification and practical measures to control rotor fluid-induced instabilities.

• **Rotor-to-stator partial and full annular rubs** - including physical phenomena, mathematical modeling, rotor modeling, rotor vibration response and pattern recognition (including chaotic vibration) for diagnostic purposes.

• **Fundamental response of rotors to imbalance and balancing techniques** - practical application of modal, multi-plane, calibration-weight balancing and polar-pilot balancing.

• **Effects of machine loose joints/parts on rotor dynamic response** - experimental and analytical studies on the dynamic effects of loose rotating parts, oversize bearings, loose pedestal interfaces and vibration pattern (including chaotic vibration) recognition for diagnostic purposes. ►

- **Torsional/lateral coupled vibrations of rotors** - measurement techniques and modeling with emphasis on the source of torsional/lateral mode coupling and effects of torsional vibrations in the shaft cracking process.

#### **Innovation through research**

It is necessary to understand machinery dynamic behavior in order to build excellent monitoring and diagnostic systems for industrial applications. BRDRC research is closely associated with Bently Nevada's Product Development efforts, stimulating the development and introduction of technologically-advanced monitoring and diagnostic equipment. Such research assisted in the development of Bently Nevada's ADRE® for Windows™ Software, 3300 System Vector Monitor, Acceptance Region Software, Digital Vector Filter 3 and Transient Data Manager®2 Software.

BRDRC papers describing research results have been presented at many national and international conferences and seminars during the past ten years. Several papers published by BRDRC staff have won national awards. The staff maintains close cooperation with leading researchers in the area of rotating machinery dynamics and is frequently invited to present lectures at national and overseas universities and research centers. Several researchers from other countries, as well as U.S. undergraduate and graduate students, have worked with the BRDRC staff at the Minden facilities for periods of two to six months.

NASA, the U.S. Air Force, rotating machinery manufacturers, the chemical and petrochemical industries, utilities and research labs are some of the clients who have benefitted from our technical resources. Bently Rotor Dynamics Research Corporation welcomes the opportunity for involvement on any scale with valuable research projects. We all stand to benefit from a greater understanding of rotating machinery behavior.

For additional information on the resources, capabilities and availability of Bently Rotor Dynamics Research Corporation, contact your nearest Bently Nevada sales representative. ■